Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2013, 5(12):631-635

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Study of sports fitness design based on safety factor

Shuang Wang[1] and Shu Yan Gao[2]

[1]*Physical Education Department, Hebei Normal University of Sicence & Technology, Qinhuangdao, China*
[2]*Physical Education Department, Hebei Medical University, Shijiazhuang, China*

ABSTRACT

The modern sports is an activity with fierce competition and rivals. During routine training, the athletes usually are trained and strengthened by using kinds of fitness equipments to achieve match requires and get high scores. In the process of designing sports fitness, high safety factor is highly demanded. Starting from the design idea of fitness's safety, this paper will study on body dimensions data, psychological suggestions of color, shape morphologic semantics and safety protection equipments in the hope of improving the safety of fitness and providing fine reserve protection and professional support for the professional training of athletes.

Key words: Fitness, sports training, Safety

INTRODUCTION

With the continuous development of national sports career and fitness project, fitness, which has many advantages such as utility, efficiency, flexibility and small footprint, has become the main equipment for professional athletes and ordinary residents to do physical exercises and plays an irreplaceable role in improving all respects of physical functions[1]. From 2007, the State General Administration of Sports spent 5 successive years in carrying out the annual inspection of the equality of indoors and outdoors fitness and found that there were different problems in design, logo, installation and maintenance[2,3]. What's more, it was found that many accidents happened occasionally because of the equipments' design and equality problems. According to the statistics, only in the first half of 2012, there were 112 accidents caused by unsafe factors of fitness, which killed 10 and injured 96. It is not only because some operators disobey the safety codes but also because that there are many accident potentials of fitness design in body dimensions, color warning, shape semantics and safety protection equipments. Therefore, it is particularly important and necessary to study the safe design of fitness.

THE DESIGN IDEA OF SAFETY

The safety of the product is a relative concept, it is relevant to the product itself. The one hand,the product itself with security risks is an important factor to induce dangerous occurrences; On the other hand, it has a close relationship with Whether the correct use in the process of using the safety of product. That is also a lot of potential safety problems in errors and unreasonable operation of a safe product[4]. Product security must be established on the basis of the safety of the product itself, the understanding of safety and safety operation.

External environmental factors of the process of operating machinery inducing operator to make mistakes behavior has been effectively controlled, thereby reducing the unsafe acts of operator, so that the occurrence of the accident to a minimum(Table 1-Insecurity in the fitness equipment during operation). Therefore, the security considerations in the product design process comprehensive and thoughtful, design process in place that have a direct link with good or bad performance of the final product safety.

Table. 1Insecurity in the fitness equipment during operation

type	miss	Example
environment	Physics, chemistry, space environment make the operation function decline	(1) Environmental factors - noise, temperature, humidity, lighting,vibration, acceleration, (2) Poor design of the working space - ①operating capacity and the control panel height, width, distance,etc.②the possibility of seat apparatus, foot, leg room.③Operating capacity.④the mobility of Machine configuration and the position of operator.
mentation	Operator psychological tension because of anxiety	(1) The operator is too nervous state (2) Through the small margin design (3) The psychological reaction force decline due to fatigue, tiredness, illness.
control	Poor controller design	(1) Arrangement and position inconsistent between Operating capacity and controller. (2) Identification of the controller is not good. (3) The standard of the controller is bad. (4) Poor controller design ① Usage ② size ③ form of the ④ protective ⑤ the displacement ⑥ mobility.
display	Poor design of the information display	(1) Arrangement and position inconsistent between Operating capacity and monitor. (2) Identification of the monitor is not good (3) Design adverse ①Instruction modes ②Instruction form ③ coding ④ scale ⑤ pointer movement

INVOLVING ASPECTS OF FITNESS'S SAFETY DESIGN DATA SAMPLES OF BODY DIMENSIONS

Body size measurement is divided into Individual measurement and groups measurement according to the different measurement object[5]. In modern industrial product design, the majority of products not to meet individual needs, but is suitable for all the public, or the needs of a specific group of people, Statistical characteristics of the body size of the fitness operator. After determining the number of samples, Sample mean and sample standard deviation is the most commonly used of the two statistics. Measurement project in accordance with the normal distribution in body size measurement, its distribution characteristics can be described using the mean $\overline{X}$ and standard deviation S. If a data file X comprising n samples which has n related values $X_1 \sim X_n$, the mean of X:

$$\overline{X} = \frac{1}{n}(X_1 + X_2 + \ldots + X_n) = \frac{1}{n}\sum_{i=1}^{n} X_i \tag{1}$$

The standard deviation of X:

$$S = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - \overline{X})^2} = \sqrt{\frac{1}{n-1}\left[\sum_{i=1}^{n}(X_i^2 - n\overline{X}^2\right]} \tag{2}$$

Standard deviation is the most commonly used statistical discrete trends reflect the data amount which represents the difference between the size of and changes. Then determine 95% of the agricultural operator body measurement data by percentile, Specific formula:

The symbol P_k represents a body percentile, It shows that the percentile percentile K is P_k. It is a boundary value which represents K% of human dimension measurement value less than or equal P_k while $(100-k)$% more than P_k.The formula:

$$P_k = L + \frac{i}{f_k}\left(\frac{kn}{100} - C\right) \tag{3}$$

i represents Group interval, n represents the total amount of samples, L represents the lower limit of P_k group, f_k represents the frequency of P_k group, C represents the cumulative frequency of groups prior to P_k group.

Height, weight, hand length are the basic body dimension datas. one of the basic body dimensions can usually be taken as independent variables, a body size is expressed as a linear function of the variables:

$$Y = aX + b \tag{4}$$

Y represents one of the basic body dimension datas, X represents one of the basic body dimensions(height, weight or hand length), a,b represents constant. The studies show that there is an approximate proportional relationship between the basic structure sizes and height, i.e, In terms of the basic body dimension, $b=0$ in the preceding formula, and the preceding formula simplifies to $Y=aX$

These factors are mainly based on the results of analysis of the behavioral characteristics of the body's physiological and psychological activities and control in the data range of human activities. As shown in Figure 1 of limbs in the body when sitting activities adjustment range. Figure 1,2 shows the maximum and optimum operation space of hands and feet when sitting, while in this area that can be safe, quick and accurate operation.

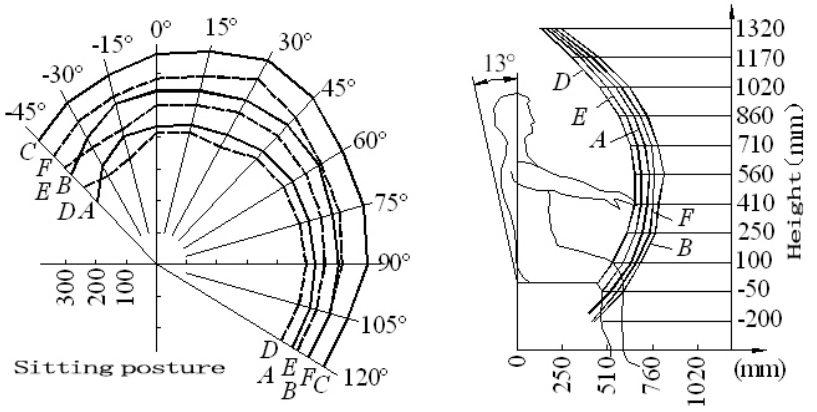

Figure. 1 Adjustment range of the limbs of our body sitting activities

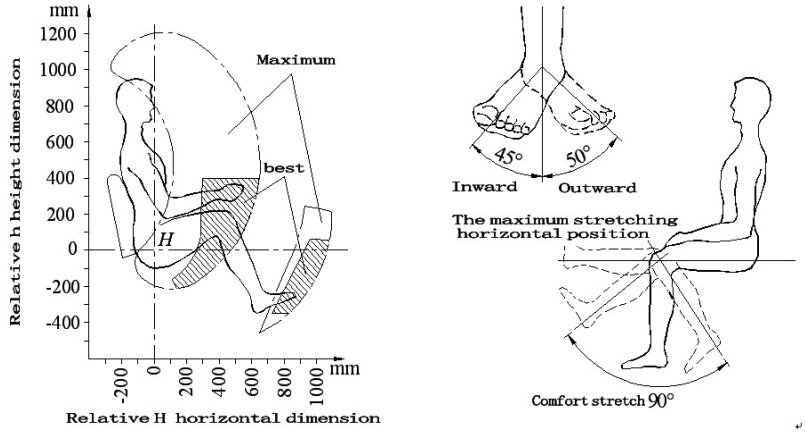

Figure .2 The best operating space of the hands and feet in the sitting condition

PSYCHOLOGICAL SUGGESTIONS OF COLOR

The color has a highly suggestive, identification for the operating personnel[6]. Therefore, pay attention to the color agreeableness in the color design can relieve and reduce the user's psychological stress, anxiety and fear. Color perception has clear rules, as figure 3 - color perception process. But also pay attention to its suggestive in the process of applying color. For example, red stands for high temperature, risk warning semantics, blue represents calm, low temperature, Green represents security and so on[7].

Therefore, reasonable color design of fitness products is conducive to enhance operation safety and accuracy[8]. The color is too bright or too dark, too monotonous or too vague will cause visual fatigue, bring safe hidden trouble. The experimental data show fitness color should choose low purity, low brightness and weak reflective neutral color. So that does not distract the fitness operator attention, and less visual fatigue. The colors of the control panel should have good legibility, less error-prone in identifiable. In color design, it is best to have a market demand survey to select the popular product color by users. No matter which kind of practices, colors should not be too many, 2-3 kinds of color collocation is preferred. The less color, the more eye-catching, the better wholeness. If the color is too

much, it is easy to look cluttered, tacky. Color design avoid top-heavy. In order to make the product is stable and light facility, security enhancement, the general fitness upper suitable with light-colored, lower part with a warm or dark.

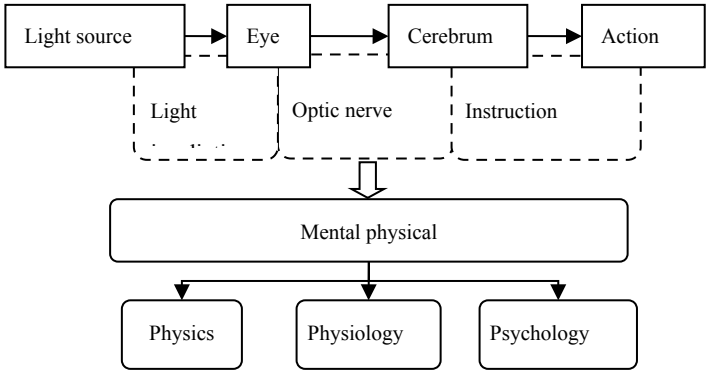

Figure3.Color perception process

Common fitness products appearance color design mainly has two kinds of methods: color harmony and color contrast. Color harmony is with the use of two or three kinds of similar and harmonious colors, resulting in harmony, unity and sedate aesthetic feeling[9] . Color contrast is two or more than two kinds of strong contrasting colors together for comparison in hue, brightness, purity, and the cold and warm area etc, resulting in exaggerated, colorful, eye-catching and stimulating effect.

SHAPE MORPHOLOGIC SEMANTICS

Shape semantics is the discipline of research form the theory of linguistic meaning. It takes advantage of the product form of semantics, allowing users of fitness to understand what this product is, how it works and how to use it. In short, will this theory to application, make a complex product has become a "from the thing", its use of visual interface form and external form to the semantic way to visualize[10]. And it is used in the design, break through the traditional human engineering only to people physical and physiological function of consideration, will design factors deep into person's psychology and psychological factors. It can be said that form of written language semantics is operator to recognize form, cognitive view to create a form of methodology. As shown in figure 4below.

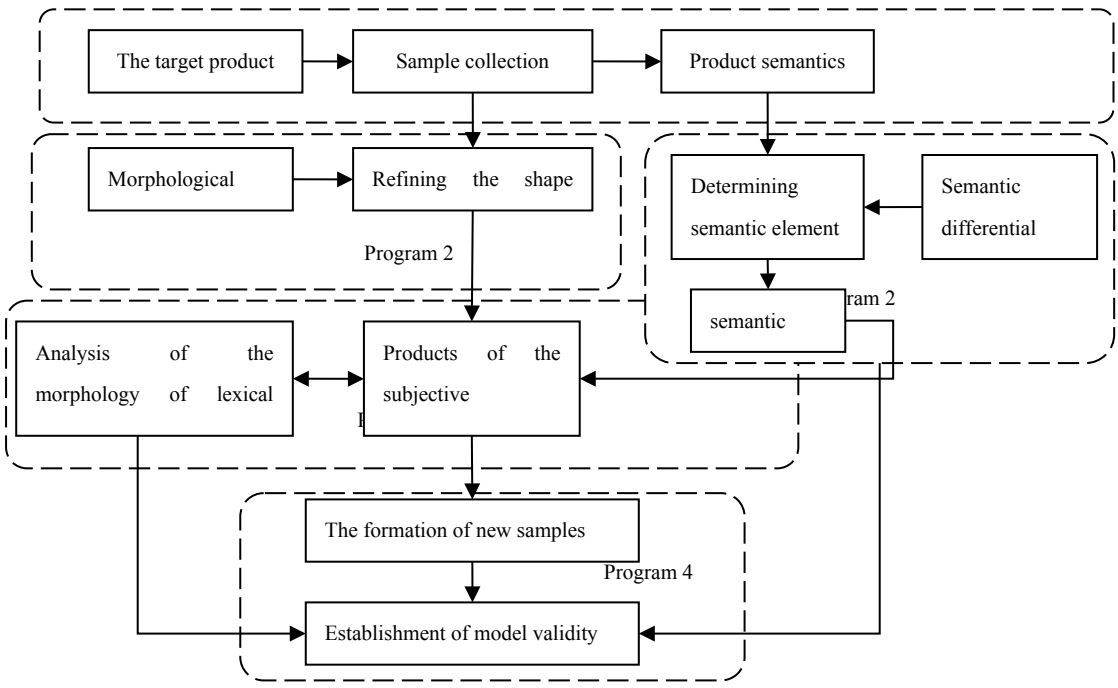

Figure4. The meaning of molding semantics

Scientific and reasonable operating interface is not only simple, easy to understand, and instructions on its use has a strong leading, not only to improve their operational efficiency, better protect the Security personnel to operate and machinery mechanical operation. The operate panel is the main interface of operator effective linkage mechanism. The size of the angle of inclination of the operate interface visual, display, Button position; the size and arrangement of joystick on the operating table, have an important influence for observation and use reasonable, comfortable, efficient and without cognitive impairment[11]. In the specific layout, due to fitness variety, not one one limited, but the basic principle is: operation panel display design should be based on the main characteristics of the visual, auditory, tactile which Accept information, in order to ensure the operator to obtain needed information quickly and correctly.

SAFETY PROTECTION EQUIPMENTS

The main function of the protective device which is an integral part of the mechanical equipment is to provide security protection through object barrier way, such as chassis, cover, cover, screen, door, closed-end devices, etc. The protective device can be used alone, can also be used together with mechanical interlock device[12]. Protective device is very important for fitness safety. It is difficult to avoid errors in the fitness operation process, but a small mistake should not cause disastrous accident. This requires that protective device must take into account operation of fault tolerance and fault tolerance design can reduce the risk, increase security, even the appearance of the misoperation, also should put the risk to minimum. In addition to the safety device and protection devices, blocking type or barrier device design is also more extensive and effective in the security protection. Although the blocking device only reinforces barriers which prevent entering dangerous operation District , can not completely prevent the dangerous operation behavior, but can reduce the probability of occurrence and alert the operator to dangerous actions.

CONCLUSION

Safety is the basis and the first element of product design and development. Experiments have shown that by studying the calculation and analysis of body dimensions, the suggestions of products' color types, the layout of equipments' shapes and the safety protection devices, the unsafe fitness factors which lies in the athletes' training are largely decreased so as to provide safety guarantee in design for athletes and ordinary fitness people and decrease the accident probability. What's more, this study is of practical and important significance in products development of "people oriented" and "safety first" and at the same time it also has some reference value to the design and development of relevant instruments.

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